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SEISMIC SAFETY ELEMENT

of The

ARVIN GENERAL PLAN

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SEISMIC SAFETY ELEMENT

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[Arvin City Council]
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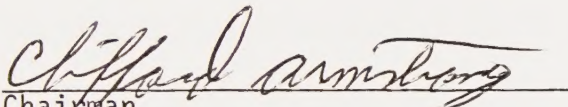
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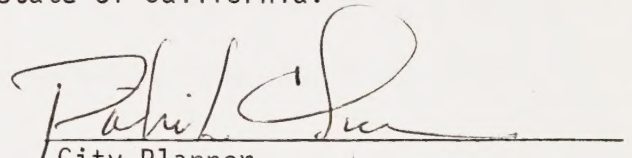
CERTIFICATION OF ADOPTION

BY THE

PLANNING COMMISSION

We hereby certify that this document, text, accompanying tables and maps constitute a Seismic Safety Element of the City of Arvin General Plan as required by Section 65302, paragraph (f) of the Government Code, State of California. This "Seismic Safety Element" being proposed as a part of the adopted General Plan for the City of Arvin was approved and adopted by Resolution No. 6-75 of the Arvin Planning Commission at its regular meeting of the First day of July, 1975, after conducting a public hearing pursuant to Section 65351 of the Government Code, State of California.


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BY THE

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We hereby certify that this document, text accompanying tables and maps constitute a Seismic Safety Element of the City of Arvin General Plan as required by Section 6532, paragraph (f) of the Government Code, State of California. This "Seismic Safety Element," proposed as a part of the General Plan, was reviewed by the Planning Commission; said Commission made its recommendation to this council; this council adopted the Seismic Safety Element by Resolution No. 36-75 of the Arvin City Council, at its regular meeting of 25th day of August, 1975, after conducting a public hearing pursuant to Section 65351 of the Government Code, State of California.

Frank Gipson

Mayor

M. C. Cline

City Clerk

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EARTHQUAKE SAFETY TIPS

BEFORE

1. Store emergency supplies; food, water, first aid kit, flashlight and battery-powered radio.
2. Take a practical first aid course.
3. Locate main switches and valves that control the flow of water, gas, and electricity into your house. Know how to operate them.
4. Support community programs that inform the public and emergency personnel about earthquake preparedness.
5. Take action to help strengthen or eliminate structures that are not earthquake-resistant.
6. Support "parapet ordinances" that would remove dangerous, unreinforced overhangs and cornices from buildings.
7. Support building codes that require earthquake-resistant construction and careful foundation preparation and grading.
8. Support land use policies that recognize and allow for the potential dangers of active fault zones.
9. Heavy furniture above the fifth floor in tall buildings should be bolted to the floor.
10. Require guard rails across the inside of plate glass windows that extend to the floor.
11. Support basic research into the cause and mechanism of earthquakes and fault movement.

DURING

1. Don't panic even if you are frightened.
2. If you are indoors, stay there. Get under a desk, table, or doorway.
3. Do not rush outside. Falling debris has caused many deaths.
4. Watch for falling plaster, bricks, and other objects.
5. If you are outside, move away from buildings and power lines; stay in the open.
6. If you are in a moving car, stop as soon as it is safe. Remain in the car.

AFTER

1. Check your family, or the people near you for injuries.
2. Inspect your utilities for damage to water, gas, or electrical conduits. If they are damaged, turn them off.

3. Extinguish open flames.
4. Do not use the telephone except to report an emergency.
5. Turn on your battery-powered radio for emergency information.
6. Don't go sightseeing. .
7. Stay away from damaged structures; Aftershocks can casue the collapse of weakened structures.
8. Stay away from beaches and waterfront areas subject to seismic sea waves (commonly called "tidal waves").

P A R T O N E

SEISMIC SAFETY ELEMENT
OF THE
ARVIN GENERAL PLAN

A. GEOLOGICAL ABSTRACT

The Seismic Safety Element of the Arvin General Plan has been prepared to help the citizens of the city protect themselves from man-made and natural hazards caused by earthquakes and other geologic phenomena. This Element is an attempt to identify, appraise and make apparent the seismic and geologic hazards effecting the city so that mitigation actions may be taken to minimize the damage, loss of life and confusion that results from major earthquakes.

The County in which the City of Arvin is located is considered one of the seismically active areas on the West Coast of the United States. Two major earthquakes have taken place in the County in historic time. The Seismic Safety Element discusses the nature of earthquakes, the causes of their destructiveness and the seismicity of the city. Assessments are made of the magnitude and recurrence interval of earthquakes and the degree of ground shaking to be expected in the city and surrounding area.

Once these factors are considered, and the hazards from this source are identified, it is usually possible to build when the appropriate precautions are taken. Maps have been prepared indicating faults in the vicinity of the city that may cause earthquakes and areas of shallow water table in which seismic shaking and lurching is likely to be severe shaking is given.

This report is not complete, because all sources of seismic activity are not yet identified. As more information becomes available, it will be added to this Seismic Safety Element. None the less, the information contained herein furnishes a sound basis for decision making and can be of enormous help in preventing damage from earthquakes and similar geologic hazards.

B. FOREWARD

The Seismic Safety Element is concerned with the various geological data that influence man's use of the land. It is to be used as the basis for developing and implementing programs to protect the health and welfare of the citizens of the City. .

This section of the general plan is designed to fulfill the requirements established by the California legislators under Section 65302(f) of the Government Code of California.

It is not intended that this Seismic Safety Element of the General Plan to be a comprehensive assessment of all geology and geological hazards; rather it identifies the major geologic land use concerns, notes where further study is needed and recommends certain policies that are consistent with the following two factors: (1) the degree of seismic risk the city is willing to support and (2) the known geologic conditions.

Technical investigations in the fields of geology and seismology were accomplished under contract with Dr. Pierre Saint-Amand, Dr. Rene Engel, and Mr. William Park, working in concert with Kern County Council of Governments and assisted by the Kern County Planning Department. Mr. Brad Williams was project coordinator for the Council of Governments.

An atlas of quadrangle maps showing the geological features was prepared for use in conjunction with this text. These maps will enable the planner, developer, and responsible governmental agency to identify zones of known seismic risk, so that adequate safeguards can be taken to protect the general public. The original 138 USGS quadrangles used in this study were provided by the Honorable Robert Mathias, United States Congressman from California. Many other U.S. Government publications were also made available to this element through this office.

The information provided by the consultants was transferred to the cronars bases by the Kern County Planning Department, Jack L. Dalton, Director; blue line paper for working prints was contributed by the Kern County Public Works and County Surveyors Department, L. Dale Mills, Director.

This Seismic Safety Element consists of ecerpts from a comprehensive study and evaluation of available seismic information entitled "Geology and Earthquake Hazards Planning Guide to the Seismic Safety Elements for Kern County." The comprehensive study is herein made a part of this element by reference. It should be used to obtain a more detailed coverage of the seismic safety program.

C. INTRODUCTORY REMARKS

The California State Legislature enacted in 1971, legislation recommended by the Joint Committee on Seismic Safety, requiring a seismic safety element as a part of the general plans of all cities and counties. The reason for requiring this element is because California has some severe and costly geologic hazards and every local government should consider seismic hazards in the planning process.

Section 65302F of the Government Code, makes mandatory the preparation of a seismic safety element consisting of "an identification and appraisal of seismic hazards, such as susceptibility to surface ruptures from faulting, to ground shaking, to ground failure, or to the effects of seismically induced water waves such as tsunamis and seiches." In July, 1972, the Governor's Earthquake Council released interim guidelines for seismic safety element. Revised guidelines were released August 20, 1973, and adopted September 20, 1973. These guidelines with some modifications due to local seismic conditions, have been used in preparation of this element. This element will assess the degree of risk that is associated with the geologic hazards that are identified. The citizens of the city will then determine the degree of geologic risk they are willing to assume as expressed during public hearings, meetings and through elected officials. Through this element, city values can be converted into preliminary seismic safety goals.

USES AND LIMITATIONS OF THIS REPORT

This element and the accompanying maps and data, provide knowledge on the type, location and extent of hazardous geologic conditions and permit comparisons of alternate land uses over large areas. This information alone is inadequate for specific site evaluation and certain types of development may require detailed geologic mapping, sub-surface exploration by drilling and trenching, soil sampling and laboratory testing beyond the scope of this element.

LIMITATIONS OF THE BASIC DATA

The completeness and accuracy of the basic geologic data are limited by several factors; the completeness with which the ground could be examined within the allotted time, the difficulty of aerial photographic observation of many terrain features in areas of extensive heavy forest cover and the lack of subsurface exploration to verify or extend the results of surface observations.

Much of the knowledge of surface geologic features is based upon the recognition and interpretation of characteristic landforms. In some cases, these interpretations are without conjecture. However, many processes modify the landscape. The time span over which they operate is long, and all their mechanisms and interrelationships are not well understood. Therefore, the interpretation of some landforms as being suggestive of geologic hazards is a projected indications.

Most bedrock and much geologic structure, including faults, are concealed by an extensive soil mantle. Information based upon the observation of features at a relatively limited number of points were extended to larger areas on the basis of geologic principles. This suffices for broad scale scientific purposes but is inadequate for understanding of local areas.

LIMITATION OF THE INTERPRETATIONS

Limitations in the reliability of the seismic risk and slope stability discussions are a function of the completeness and accuracy of the basic data, and of the validity of the interpretative techniques. Seismic risk and slope stability explanations have come into existence only within the past few years. They are now a common product of geologic studies for planning. The definitions are expressed in maps which go beyond the conventional plotting of geologic data. In part, they are predictions of the future relative density and frequency of occurrence of geologic phenomena (such as landslides). These predictions are based upon geologic principles, the geologic data, and anticipated possible alterations of the natural environment. Because most geologic events occur slowly or sporadically over long time intervals, it has been virtually impossible to test these interpretations by reference to subsequent events. The use of these maps must be qualified by the understanding of the judgemental, predictive and largely untested nature of the interpretations.

The geologic maps and interpretations are in a "plastic" form. They can and should be modified to include new facts and understanding that develop.

D. SEISMIC GOALS AND POLICIES

1. OBJECTIVE OF THE SEISMIC SAFETY ELEMENT

The objectives of this plan are to prevent or at least reduce the loss of life, injuries, property damage and social and economical dislocation resulting from future earthquakes. Due to the sudden and unpredictable nature of seismic events, it is essential to adopt and implement policies which attempt to secure the highest possible degree of public protection. Such policies must realistically consider all segments of the populace without socio-economic bias.

It is the purpose of this element to examine the scientific data relevant to seismically induced hazards and to determine land use policies consistent with the evidence. Therefore, the following policy statements regarding seismic events were adopted:

- a. The personal safety of the people must take precedence over all other factors.
- b. Structures designated for command control of emergency/disaster services should be designed to withstand a "maximum probable seismic event" and to remain operational.
- c. Structures utilized for emergency services, schools, and hospitals should be designed to protect human life to the highest degree possible during a "maximum probable seismic event."
- d. The Conclusions and Recommendations included in this Seismic Safety Element should be accepted as guidance for the preparation of local ordinances.
- e. The local legislative body should adopt specific ordinances aimed at protecting human life from the effects of a "maximum probable event" of seismic activity.
- f. The legislative body should establish procedures for collecting additional data and periodically updating the ordinances.

2. PUBLIC INTEREST AND PARTICIPATION

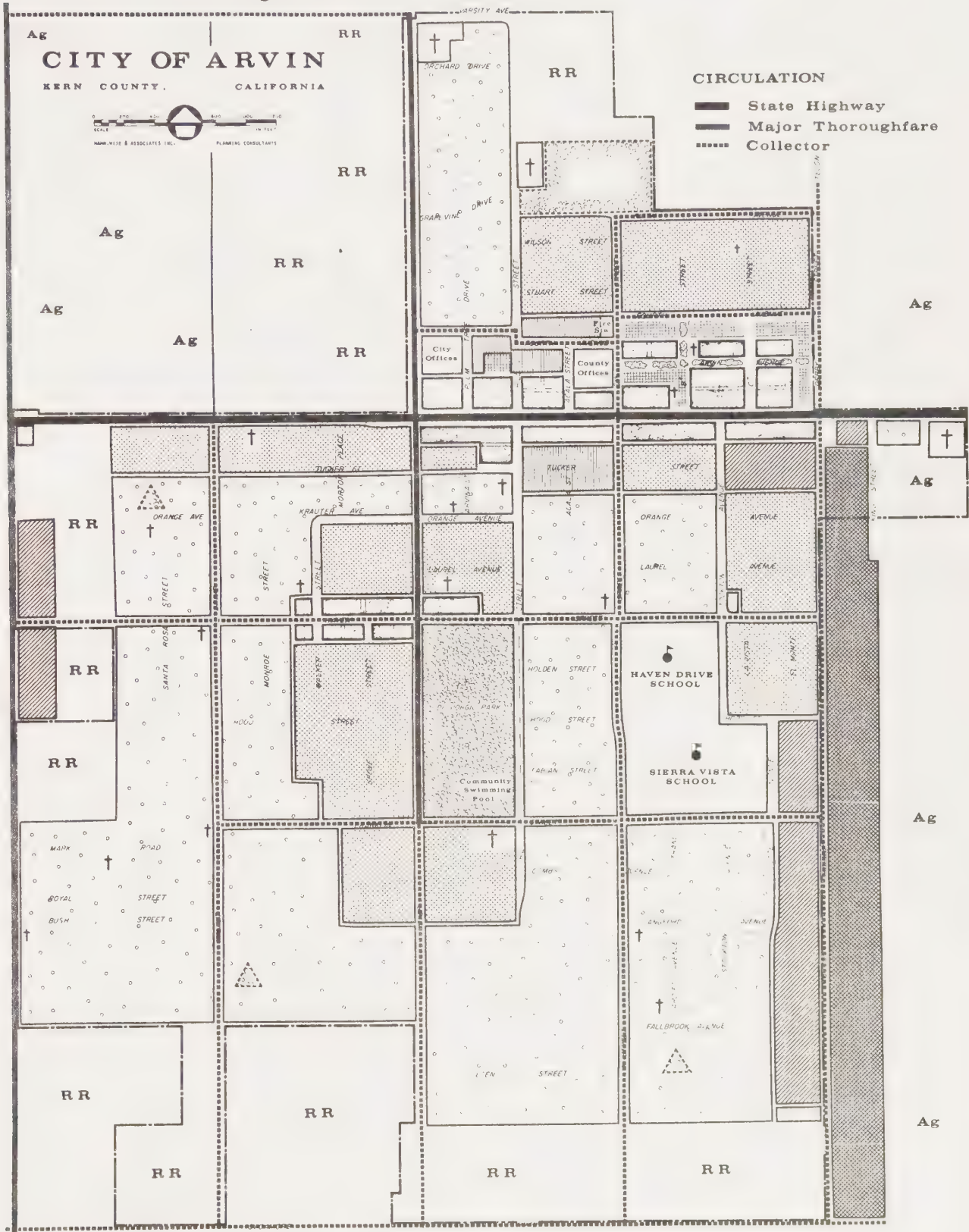
The Seismic Safety Element informs the public regarding specific local seismic hazards. It identifies means available to reduce risk and damage. Through disaster preparedness plans, it enables the public to respond to emergencies. Public Participation is necessary to help decision-makers determine the most acceptable policies regarding risks in relation to classes of land use, building use, and occupancy factors.

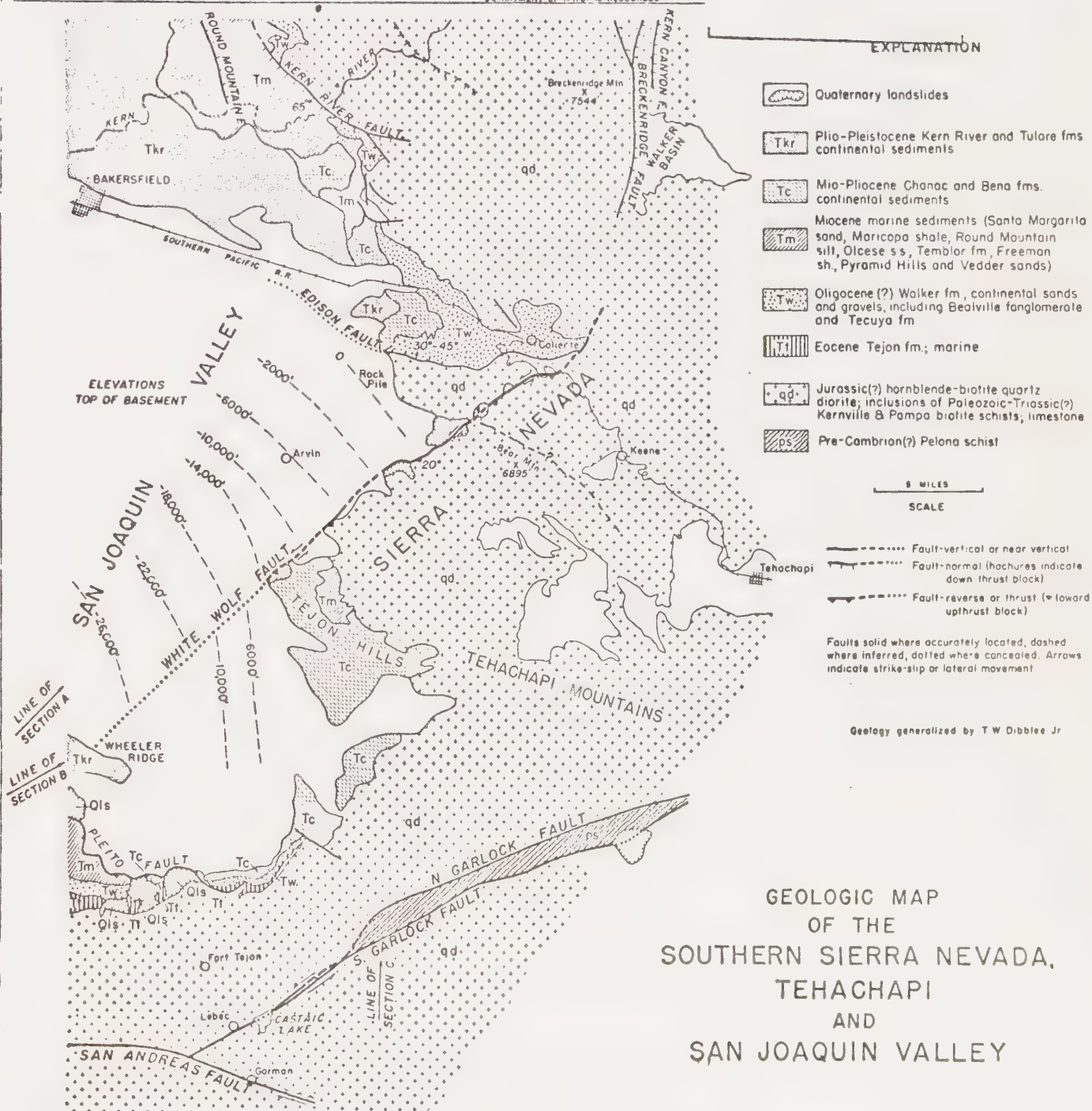
As an essential part of the planning process, citizen participation is started early in the program for the purpose of developing basic community goals and objectives (Section 65304, Gov. code). When alternative planning concepts have been developed, there should be public review of the options through public conferences or other appropriate forums. The possible impact of each option needs to be carefully examined. Prior to official public hearings, meetings with the public are needed to explain the content of a proposed plan to enable the public to come to hearings with better knowledge of the plan and its contents. The press should be informed as to the content of a proposed plan and the status of the planning program. Finally, published materials on the general plan should be distributed as widely as possible before public meetings or public hearings are held.

Successful citizen participation will generate support for implementation of public plans and policies after official adoption. Technical committees can also be utilized where a community is faced with particular natural resource problems.

GENERAL PLAN

Arvin High School





II

CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

1. SEISMICITY AND GEOLOGY

- a. Earthquakes have been and will continue to be a major hazard in Kern County. While major earthquakes are infrequent, they are disastrous. Smaller earthquakes are now recognized as a real danger because the area is becoming built up and events as small as magnitude 6 can cause severe problems over a small area.
- b. Earthquakes as large as magnitude 8 to 8.5 may be expected once or twice a century, at distances short enough to cause considerable damage in the county. Earthquakes of magnitude 6 can be expected every ten years or so. Most of these will occur in unpopulated areas and the damage done by them will not be important unless they occur within a few miles of a populated area.
- c. It may be reasonably assumed that all of the faults in the county, with few exceptions, are capable of further movement. The most important faults are: San Andreas, Garlock, Sierra Nevada, White Wolf, Big Pine, Kern Canyon, Bear Mountain, and perhaps some large faults buried under the alluvium of the San Joaquin Valley.
- d. The Breckenridge fault system and the east and west branches of the Edison fault located in the central part of the county may be expected to generate earthquakes of magnitude 6 or greater.
- e. The determination of the relative degrees of activity of different faults and of the degree of severity of other geological hazards are still uncertain and require more study before it becomes possible to delineate meaningful hazard zones.
- f. The intensity of shaking from an earthquake on any fault decreases with distance from the fault, except in areas where deep, saturated alluvium can augment the ground motion. A large part of the San Joaquin Valley is subject to this effect.
- g. The most serious threats are confined to the valley areas, where in addition to aggravated shaking, the possibility of liquefaction and failure of clay horizons adds to the difficulty by creation of differential settlement.
- h. Areal subsidence, both naturally constructed and artificially induced, is an important problem in the southern and western San Joaquin Valley. A large earthquake will aggravate this situation.

- i. Seismic activity, such as a large earthquake, will cause problems related to landsliding and other forms of mass movement over most of the county. Rock falls, avalanches, soil creep and mudflows are a problem in the mountains. Landslides, soil creep, soil flows, failure of clay rich formations and similar types of mass movement are to be expected in the San Joaquin Valley. Failure of dikes, canals, levee systems and irrigations ponds are to be expected over most of the agricultural parts of the county.
- j. There is no probability that Kern County will be affected by tsunamis originating in the Pacific Ocean.
- k. Seiches (oscillation of lake surface) in lakes are a real possibility. Lake Isabella, Kern Lake and Buena Vista Lake are likely candidates and real estate lakes should be examined to be certain that seiches therein will not cause trouble to construction on the edges of the lakes.
- l. Displacements along faults and creep-along faults are likely to affect those areas in the immediate vicinity of the larger faults. Construction of pipelines, aqueducts and similar works across or along fault zones should be done so as to minimize the likelihood of damage from this source and should be so arranged that repair is easy.
- m. While a number of Pleistocene and recent volcanoes have been active in and around the county, none are at present active. Volcanism is therefore not a serious threat.
- n. Flooding as a result of failure of levees, dams and similar structures for retaining water is a real possibility. As an example, the dam at Lake Isabella is situated near an important fault in such a way that movement on this fault could endanger the dam.

2. EMERGENCY SERVICES

- a. The Kern County and the city emergency services are organized to respond to emergencies and disasters caused by natural or wartime conditions. This division of the General Services Department in the County and the Public Works Departments for the cities, has assigned emergency operating functions to specific agencies and has designated personnel to serve in the command and control role in a widespread emergency.
- b. An inventory of vulnerable structures which could endanger public safety during a seismic event, and a plan for mitigating hazardous conditions must be made available soon.

- c. The Emergency Services are organized to respond rapidly to a seismic disaster by providing emergency medical treatment for the injured, operating as part of a regional communications network, instituting emergency law enforcement deployment to protect public safety, and restoring to operation those municipal facilities which have suffered damage.
- d. A study should be made which assesses the hazard to life and the economic loss that would result from failure to the dam at Lake Isabella and of the canals.

B. RECOMMENDATIONS

1. Before engineers will be able to make the best possible recommendations and calculations as to the types and methods of construction it will be necessary to know more about the intensity of shaking of earthquakes. To this end then, State, County and Local governments should continue to support research on geologic hazards and to encourage the Federal Government to do the same. Of utmost importance is the program of installing and maintaining strong motion seismographs throughout the country. This program should be continued and expanded. Following a few more strong earthquakes, with instruments at a variety of distances from the causative fault and on a variety of soil and rock types, it will be possible to set down realistic standards so that the intensity, duration and frequency of shaking can be specified for the type of earthquake likely in a given locality. Without this information, it is difficult to design correctly and the only assurance of safety lies in an uneconomical overdesign. With this information in hand, and with further study into the techniques of earthquake resistant design for buildings of various types and sizes, it will be possible to prepare, enact and enforce earthquake codes that do not depend upon building lore, but which will be able to take advantage of the latest state of the art in construction. Further work on the earthquake resistance of dams is also needed.
2. The fault zones, designated on the maps in the Atlas as shaded areas should be declared Geologic Hazard Areas. Wherever possible, these areas should be zoned for use as open space with such agricultural and recreational uses as are consistent with the hazards involved. Minimum lot sizes for future subdivisions should be set at 10 or 20 acres depending upon the circumstances. High density land use should be prescribed in these areas because the cost to the county in the event of a calamity could easily outweigh the benefits of such land use.

Before any construction permits are granted in these areas, Environmental Hazard Reports should be prepared by a registered geologist and checked by a geologist retained by the local government agency having jurisdiction in the area. The planning agency should then use the report to determine if the proposed construction is suited to the type of land use designated for the area and if the risks involved are adequately met by sound construction practice.

3. Special structures that house numerous people, or incapacitated people, such as hospitals, sanitoriums, health care units, schools, colleges and auditoriums, should not be constructed in Geologic Hazard Zones. Police and Fire stations and other structures used by the Emergency Services, should not be constructed in such zones, but if they must be placed there for good reason, then special care must be taken in the construction to assure that they will not fail during the maximum expectable earthquake.
4. Buildings such as specified in Paragraph 3 above should be built to more than ordinary standards and must not collapse during the maximum expectable earthquake. The California Field Act, adopted after the 1933 earthquake in Long Beach sets the highest standards ever specified for the construction of school houses. It does not apply to other structures. All schools built in the state must conform to the Field Act.
5. The Uniform Building Code of 1973, designating Kern County as within Seismic Zone 3, should be adopted by all local jurisdictions. The new earthquake code for taller buildings in Los Angeles City (See Appendix F) should also be adopted. (For information and comparison with other codes the earthquake regulations of the 1968 Los Angeles County Building Code are attached as Appendix E.) These should be regarded as interim measures to be amended, supplemented or replaced at a later date as more progress is made in this field.
6. A long range, building inspection program, to identify dangerous structures should be drawn up and executed as rapidly as possible by the several cities and by the county. Once a dangerous structure has been identified, no further enlargement or improvement thereto, except as necessary to make no structure safe, should be permitted. The use of such buildings as are uncorrectable, should be phased out as rapidly as possible and the worst of them taken out of service and removed.

An ordinance to deal with seismically unsafe buildings and with unsafe architectural appendages should be promulgated. This should call for inspection, repair or demolition, either before or after an earthquake. Provision should be made however for preservation of architecturally or historically significant structures.

7. Where important, the effects of liquefaction, or failure of clay rich or saturated soils should be taken into account in construction and special consideration should be given to the possibility of landsliding in those areas where it is an identifiable problem.
8. The threat of flooding of large areas of the San Joaquin Valley following a major earthquake are important enough to require a special study of the hazard as related to dam and levee stability and recommendations for positive action to correct such situations as may be identified should be made.
9. A Seismic Safety Commission should be established with responsibility for implementing the Seismic Safety Element. This commission should periodically up date the element, make suggestions for changes in codes and design requirements, as well as supervise necessary drills and tests that are conducted by the Emergency Services at regular intervals.

10. The Seismic Safety Element should be reviewed on a yearly basis and be comprehensively revised at least every five years or sooner, whenever substantial new scientific information becomes available.
11. Work by professional structural engineers has resulted in the development of techniques by which dynamic analysis of structures can be performed by high speed computers. It is recommended that the use of such calculations be, in the future, made the basis of the county code for the construction of large buildings. It will thus be possible to economically design such structures with little possibility of failure and to take advantage of the latest constructional techniques as they become available. It would be wise to try out this system on some of the larger county buildings to see if they are earthquake safe.
12. Instability of slopes along highways, canals, river banks, in the foothills and mountain areas should be investigated in the near future.
13. Protection zones against seiches should be established after investigation, along residential and recreational areas around Lake Isabella, Buena Vista Lake and others, and enforced by an appropriate ordinance.
14. The Federal Emergency Services Administration should be requested to provide on-site assistance to local agencies through the State Office of Emergency Services, as necessary when asked by the commission.

C. IMPLEMENTATION

Implementation is the administrative process by which the citizens of the jurisdictions and all its component communities are brought together in a cooperative effort to institute and maintain the design.

Phase I

The preparation of the Seismic Hazard Atlas and adoption of this text constitutes phase I of the Seismic Safety Plan.

Phase II

This phase of the Seismic Safety Program is to be undertaken by the Planning Commission subsequent to the adoption of this element by the decision-makers. The steps that are necessary for the implementation of the plan are outlined at the end of this section.

The information system described should enable the elected officials to make rational decisions concerning the future growth and development of his community. The planner works closely with this data and employs his professional judgement based on long experience with planning problems. Such a background is frequently denied the lay political leader,

The political leader addresses himself to a host of problems other than planning and commonly finds the atmosphere in which he operates more frenzied and harried than the surrounding the work of the planning agency. Recognizing this, the planner must show to the political leader, in terms that hold his interest, just what a design will do for the area and its people.

The ideal situation would be one in which planners and political leaders and representatives from the community work together in establishing community planning goals. A joint effort to formulate explicit goals would have two desirable results:

1. The issues of planning would be better integrated into the political process and would therefore be elevated from the realm of local interest to the more critical realm of community interest. Most planning issues have an impact beyond the immediate community and should be of concern to the entire region.
2. Political leaders who control the implementation of plans will have taken part in the goal-formulation process and will therefore have subscribed to the plan. If they do not support its implementation, they run the risk of being inconsistent.

In short, cooperation between planner and political leader is essential if planning is to be successful in a democratic society. An information system should provide the data upon which sound planning is based and by which it is judged. But to make a plan a reality requires an understanding of the role that both the professional planner and the political leader play in the planning process.

PLAN IMPLEMENTATION

The following steps are necessary for the implementation of the plan.

1. Concurrent or subsequent revision of other general plan elements to give specific recognition to seismic safety policies and criteria.
2. Inclusion of appropriate requirements and procedures in zoning, subdivision and site development regulations and building codes. Designation of special zones with special zones with special land development regulations such as "seismic hazards management zones".
3. Preparation of renewal plans for areas where a change in use and development pattern is proposed because of major seismic damage or extreme hazard.
4. Building inspection program to identify unsafe structures and instigate necessary corrective measures.
5. Inclusion of potential earthquake destruction in contingency plans for major disasters and emergencies. Review and liaison with Emergency Preparedness Organizations and Police Departments of overall plans and major public facilities proposals as to their adequacy in emergency situations.
6. Educational programs to develop community awareness of seismic hazards.
7. Implement recommendations proposed in Chapter IX, of General Plan.

NOTE: Implementation programs described above are consistent with the following:

Suggested Interim Guidelines for the Seismic Safety Element in General Plans, prepared by the Governor's Earthquake Council, July, 1972.

Draft Guidelines for the Seismic Safety Element, prepared by Advisory Group on Land Use Planning for Joint Committee on Seismic Safety, California State Legislature, September, 1972.

Seismic Safety Concerns in CIR/OIM Program, prepared for CIR by William Spangle & Associates, March 1972, unpublished.

D. ACTIVITIES FOLLOWING ADOPTION

Following adoption of the general plan, the Planning Commission is required to: (Section 65400)

- a. Investigate and make recommendation regarding implementation.
- b. Submit annual report to local legislative body on status of the general plan and its application.
- c. Promote public interest in and understanding of plan and regulations.
- d. Consult and advise (with others) on ways of carrying out the plan.
- e. Review referrals as to conformity with the general plan (all real property acquisitions and dispositions, construction of buildings and other structures). Section 65402
- f. Develop and adopt regulatory programs (zoning and subdivision ordinances, building and housing codes and other devices) which will implement the policies described in the general plan.

Following the adoption of the general plan, the local legislative body may designate an official agency to list and classify and coordinate a program of the public works proposed by all agencies with projects recommended for the ensuing year. Such a program is then submitted to the Planning Commission for review and report to the official agency as to conformity with the general plan. Section 65401

The Planning Commission may, or if so directed the legislative body shall, prepare specific plans based on the general plan and drafts of such regulations, programs, and legislation as may, in its judgement, be required for the systematic execution of the general plan. The Planning Commission may recommend such plans and measures to the legislative body for adoption. Section 65450

This directive provides the Planning Commission and the local legislative body broad authority to develop coordinated plans and programs to implement the general plan.

Dr. Engel is presently developing a method for evaluating areas according to the degree of hazard from seismic related events. It is anticipated that quantitative values representing seismic risk can be shown on maps. This type of information would assist planners in determining the appropriate land use construction method and engineering studies.

P A R T T W O

BACKGROUND INFORMATION
SEISMIC SAFETY ELEMENT
OF THE
ARVIN GENERAL PLAN

III

DISASTER CONTINGENCY PLANS

A. GENERAL STATEMENT

Earthquake losses are largely avoidable. For this reason, the County of Kern and each city therein, is required by state law to have contingency plans for preparedness in the event of either natural or man-made disasters. Earthquakes should be specifically included and given special treatment in such plans. Earthquakes, because of their regional extent, are, of all natural disasters, capable of inflicting the greatest loss of life and property. They may happen, without warning.

In addition to the hazards already mentioned in Part I, earthquakes may trigger events which result in disastrous fires, floods and the displacement of people. As an example: The 1906 San Francisco earthquake was, for many years, referred to as the "San Francisco Fire," because of the holocaust that was triggered by the earthquake. Virtually all of the damage was due to the fire. As recently as February 1971, about 80,000 residents were evacuated because of a flood danger that would have resulted from the possible collapse of the Van Norman Dam, damaged during the San Fernando earthquake. Fortunately, the reservoir was successfully drained without catastrophic dam failure.

When lack of reliable warning is coupled with multiple hazards, such as earth shaking, flooding, and fire, preparedness measures must take into account the particular vulnerability of the community that is at risk. Such measures must consider the population, buildings, roads, utility networks, and emergency services.

B. KERN COUNTY EMERGENCY PLANS

The Kern County Emergency Plan and those for each of the eleven cities were developed in accordance with the California Emergency Act (Government Code, Article 10, Chapter 7, Division 1 of Title 2) and Kern County Ordinance No. A-257 of October 3, 1972, to serve as a guide for the coordination of emergency preparedness and operations, before, during, and after a nuclear attack, other types of warfare or a natural disaster.

Act No. A-257 was implemented by resolution 72-723 and 72-795 of the Board of Supervisors of Kern County, to provide for the organization of emergency services in the unincorporated area of the county. Each city has taken or will take similar action.

These Emergency Services are derived from, and require, close cooperation between the operation departments and the branches of the Kern County government and of the eleven cities. They form an organization adaptable to all possible types of emergencies.

IV

STRUCTURAL AND NON-STRUCTURAL SEISMIC HAZARDS

A. Pre-Earthquake Planning by Public

Much of the damage produced by an earthquake can be avoided if care is taken, during routine fire and other building inspections, to call attention to items that could be an earthquake hazard. Many fires are caused by improper storage of chemicals and solvents. Considerable injury results from fall of unstable objects such as bookcases, filing cabinets, pictures and fluorescent light fixtures. Corrective measures are simple and cheap. A public awareness of such problems should be created by working with property owners and by appropriate publicity given to identification of such situations.

B. General Statement

The most urgent priority in the Hazard Abatement Plan of the SSE is the inspection and evaluation by the Engineering Group (see Chapter II, Section B-1.f),** of structural damage that may result from future seismic activity. A priority listing should be made of structures after a critical examination to determine whether they meet community standards, whether they must be repaired, or whether they should be demolished because reconstruction cost exceeds a predetermined percentage of the value of the building.*

On the same priority list, identify and cause to be removed from buildings all non-structural parts deemed to be hazardous. This includes but is not limited to features such as cornices, parapets, unsafely anchored signs, etc.

The public should have explicit notice of buildings that constitute potential seismic induced structural hazards. This could be accomplished by requiring all potentially dangerous structures to be posted with signs indicating that their seismic safety is suspect.

Generally, existing substandard structures of all kinds constitute the greatest hazard to a community and mitigation processes described should be immediately activated.** There should be a continual on-going program to reach a status of economically acceptable safety, commensurate to the degree of structural soundness the community is willing to support.

Examination of structures should be scheduled according to a priority list and simplified guidelines. A procedure such as the age date base used in the Field Act of 1933 and giving two classes-pre-reference date and postreference date structure - could be used. It should include the type of control (community, state, federal, or private), and type and duration of occupancy (man-hours per day), physical condition and location. Each community should have a dangerous building ordinance to cover existing structural and non-structural hazards, similar to the 1973 Dangerous Buildings Code (Volume IV of the Uniform Building Code), modified to specifically treat earthquake risk.

- * International Conference of Building Officials' "Dangerous Building Act."
- ** "Geology and Earthquake Hazards," Planning Guide to the Seismic Safety Element, Kern County, California.

NATURAL SEISMIC HAZARDS

A. GENERAL STATEMENT

A list of natural seismic hazards investigated and analyzed in the SSE is given on page I-2 under paragraph B-2.* An overview of the environment in which seismic hazards develop under the influence of natural forces is presented in Appendix G, under the title "Outline of the Geology of Kern County."

Seismic and geologic hazards in Kern County were identified and delineated by compilation and critical study of all available published data, supplemented by field work in selected areas. This information was transferred to 7½ min. USGS topographic quadrangle maps (the largest published scale - 1:24,000 or about 1 inch = 2,000 ft.) so as to be clearly understandable by anyone concerned with land development or construction.

B. SEISMIC HAZARD ATLAS - Detailed Maps

The Seismic Hazard Atlas accompanying this study is intended to draw the attention of builders, developers and planners to areas of possible geologic and seismic hazards to existing and future structures.

The information shown has been collected from a wide variety of sources. Liberal reference has been made to published and unpublished data from the United States Geological Survey, California State Division of Mines and Geology and the California State Division of Oil and Gas. Because of the generous cooperation of oil and gas companies and consulting geologists in the Kern County area, some of the information shown in this study has come from confidential files not previously published. Many years of experience, in the Kern County area by the authors, have been drawn upon in data collection, collation and interpretation of a large volume of information.

The reader is cautioned that most of the source data is of a regional nature and the science of geology is often highly interpretative, particularly in the subsurface. Because of the breadth of this study and time limitations, a thorough check of source data and field investigation was impossible. Even though a great deal of information may be shown in some areas this should not be considered as a detailed study of any particular parcel of land. Nor should it be concluded that no hazards exist in a particular area simply because no data were available.

The basic data presented in this portion of the Seismic Safety Element are as follows: (1) Rock Types, (2) Rock Structure, (3) Landslide Data, (4) Shallow Water Tables, (5) Earthquake Epicenters, (6) Fault Characteristics and (7) Subsidence.

*"Geology and Earthquake Hazards; Planning Guide to the SSE for Kern County"

C. POST EARTHQUAKE - STRUCTURAL DAMAGE AND HAZARD EVALUATION

Damages to structures are surveyed and then evaluated and placed on a priority basis by the Engineering Group. From this investigation will emanate decisions relating to the degree of risk most acceptable to the community either to repair or to demolish the damaged buildings. This group will decide on the action to be taken. In addition to the buildings, this survey is to include damages to public utilities, roads and highways, railroads, airports, dams and canals, agricultural and industrial plants and to the land. All hazardous and potentially hazardous conditions caused by ground movement and rupture should be listed. This also includes the damages which may result from mass movements such as mudflows and landslides.

The Kern County Building Inspection Department has established standard procedures for inspection and reporting of damage as a result of earthquakes and other disasters (Administrative Bulletin #1 of August, 1972).

For the sake of uniformity, each city should adopt this procedure. The county is divided into three areas with command posts in Bakersfield, Shafter, and Ridgecrest.

It is recommended that the seismic safety condition of existing structures be a major factor in the selection of urban areas for redevelopment.

Suggested Priority Action Schedule

- a. Post signs in dangerous structures to warn the public.
- b. Remove all dangerous, outer, non-structural parts of buildings.
- c. Warn building occupants of inside dangerous hazards such as: partitions, glass, elevator counterweights, poorly anchored library stacks and shelves, improperly placed bottles in chemical laboratories, etc. Routine fire inspection prior to earthquakes can identify, and cause to be corrected, such hazards.
- d. Safety inspection of public and community buildings and the evaluation of degree of risk with recommendation when necessary for repair, demolition or replacement.

MODIFIED MERCALLI INTENSITY SCALE OF 1931

(Abridged)

(From Barosh 1969)

- I. Not felt except by a very few under especially favorable circumstances.
- II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
- III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing of truck. Duration can be estimated in some cases.
- IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
- V. Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned, disturbance of trees, poles and other tall objects sometimes noticed. Pendulum clocks may stop.
- VI. Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.
- VII. General alarm; all are frightened and run outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.
- VIII. Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected from ground in small amounts. Changes in flow of springs and wells. Steering of motor cars affected.
- IX. Damage considerable in specially designed structures; well designed frame structures thrown out of plumb; damage great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.
- X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Walls bent. Landslides considerable from river banks and steep slopes. Sand and mud shifted horizontally on beaches and flat land. Water splashed (slopped) over banks.
- XI. Few, if any, masonry structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipe lines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
- XII. Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air.

HAZARD COMPARISON OF NON-EARTHQUAKE-RESISTIVE BUILDINGS

This table is intended for buildings not containing earthquake bracing, and in general, is applicable to most older construction. Unfavorable foundation conditions and/or dangerous roof tanks can increase the earthquake hazard greatly.

<u>SIMPLIFIED DESCRIPTION OF STRUCTURAL TYPE</u>	<u>RELATIVE DAMAGEABILITY</u>	<i>Increasing susceptibility to damage</i>
Small wood-frame structures, i.e. dwellings not over 3,000 sq. feet and not over 3 stories.....	1	
Single or multistory steel-frame buildings with concrete exterior walls, concrete floors, and concrete roof. Moderate wall openings.....	1.5	
Single or multistory reinforced-concrete buildings with concrete exterior walls, concrete falls, and concrete roof. Moderate wall openings.....	2	
Large area wood-frame buildings and other wood frame buildings.....	3 to 4	
Single or multistory steel-frame buildings with unreinforced masonry exterior wall panels; concrete floors and concrete roof.....	4	
Single or multistory reinforced-concrete frame buildings with unreinforced masonry exterior wall panels, concrete floors and concrete roof.....	5	
Reinforced concrete bearing walls with supported floors and roof of any material (usually wood).....	5	
Buildings with unreinforced brick masonry having sand-lime mortar; and with supported floors and roof of any material (usually wood).....	7 up	
Bearing walls of unreinforced adobe, unreinforced hollow concrete block, or unreinforced hollow clay tile.....	Collapse hazard in moderate shocks	
Source: Abridged from Pacific Fire Rating Bureau Tariff Rules		

D. COMBINED HAZARD EVALUATION

1. GROUND SHAKING

The city is in an area of the San Joaquin Valley subject to moderate to severe ground shaking. This hazard is produced by the buildup of potential energy along major fault systems that may suddenly be released.

Of the 6,700[±] foot thickness of sedimentary cover over the crystalline basement complex, approximately 1,900 feet is composed of younger sediment. This condition is conducive to the propagation of elastic seismic waves.

A program should be initiated to inventory and systematically eliminate existing structural hazards that could endanger people's lives and property in the event of an earthquake.

New construction proposals should be reviewed by the Building Inspection Department to determine if the minimum requirements of the Uniform Building Code are adequate for each particular site. Construction plans other than single family dwellings should be subjected to additional studies described on page 42, items 4 and 5.

Because it is difficult to predict strong motion characteristics and their effect quantitatively, high-rise structures that have a long fundamental period equivalent to that of the ground response should be analyzed by structural engineers.

Underground utilities, roads, and concrete lined canals are vulnerable to ground shaking. Consideration should be given to their design and construction in order to provide uninterrupted service.

2. GROUND FAILURE

Landslides

The land within the city boundary is situated on a gentle southwest slope of the valley, not subject to significant landslides or soil creep.

Flooding Induced by Seismic Activity

This hazard appears to be minimal from causes within the city, however, flooding within the city caused from conditions outside the city is possible. The damming by landslides of intermittent streams in the adjacent mountains and subsequent failure of the dam is a significant hazard.

A flood plain management program should be initiated in cooperation with the county to mitigate this hazard.

Land Subsidence

This type of ground failure can be triggered by ground shaking; it can also be a condition related to normal differential compaction of unconsolidated sediments, it can be caused by the addition of water to certain soil types (hydrocompaction), or it can be caused by withdrawal of large volumes of fluid, either water or oil. Arvin has experienced some subsidence, approximately 1 to 2 feet in the past forty years (Map No. 4 of the Seismic Safety Atlas). This slow rate of subsidence may continue as oil and water are withdrawn from the underground reservoirs. Water recharge may slow or halt this subsidence. At present the center of subsiding area 12 miles to the southwest of Arvin has experienced 7 feet of subsidence since 1926. Subsidence may cause some maintenance problems of roads and underground facilities in the city. New installations of underground facilities should be engineered to withstand the continuation of subsidence.

Clay Soil

No significant amount of clay soil, which expands when wet, thereby impairing the foundations of large structures, is recognized in this area.

Liquefaction

Liquefaction does not appear to be a significant hazard at Arvin. No shallow perched water table is recognized; The water table is at a depth of approximately 210 feet.

Erosion

Soil erosion, a geologic hazard that can be aggravated by ground shaking and offset along a rupture, does not appear to be a significant factor in the city of Arvin.

3. SURFACE FAULT REPTURE

No active faults (i.e. fault having displaced quaternary rock of the Holocene Epoch) are recognized in the city boundaries.

The White Wold and Edison faults near Arvin are recognized as being active faults in the vicinity. Two faults, Temon Thrust and Tejon Canyon Fault, within the city were interpreted from subsurface data. There is no indication of recent movement along either fracture, so they are not considered as being hazardous at this time.

EVALUATION CHART

CITY	POPULATION	AREA WITHIN CITY BOUNDARY (Acres)	DENSITY Persons/Acre	SEISMIC HAZARD MAP		DEPTH TO WATER (Ft.)	THICKNESS YOUNGER SEDIMENTS (Ft.) Pleistocene or Younger	DEPTH TO BASIN ENT COMPLEX (Ft.)	Ground Shaking (1)	Nearest Fault (2) (miles)	NO. OF EPI CENTERS WITHIN 5 MI RAD (3)	POTENTIAL HAZARDS (5)										PRE-EARTHQUAKE		TYPES OF LAND USE
				NAME	NUMBER DESIG.							NATURAL						STRUCTURAL				Planning	Blgd. Inspect.	
												Fault Rupture	Ground Shaking	Clay Soil (4)	Landslide	Settlement	Flood	Bldgs.	Dams	Pipelines				
Arvin	5,375	740	7.3	Arvin	6D1	210	1,900 ±	6,700 ±	.5	3	25	2	3	2	1	3	2	2	1	2	None	None	Agriculture Oil	
Bakersfield	74,700	19,952 Total -3,200 Sewer Farm 16,752	4.5	Oilfield Oil Center Gassford Latent	5C1 6C2 5C3 6C3	5' to 500 ±	1,400 ± to 3,800 ±	7,087 ± to 11,500 ±	6	6	6	2	3	3	2	2	3	2	3	2	In Process	In Part	Oil, Mfg.-lt. Agriculture Commercial	
California City	2,300	119,040	.02	Mojave Sanborn Saltlake SE Castle Butte SE Castle Butte Desert Butte Johannesburg	9D 9D4 10C4 10D4 10D 10D3 11C3	300	0 to 700 ±	0 to 1,000 ±	32	10	1	2	2	1	1	1	2	2	1	1	None	None	Commercial	
Delano	15,350	4940 Total -1000 S/P - 60 S/P 3880	4.0	Fond Delano E McFarland Delano W	4B1 5A3 5B2 4A4	70	1,500 ±	7,000 ±	35	9	0	2	2	1	1	3	2	2	1	1	Complete	None	Mfg.-lt. Agriculture	
Maricopa	740	450	1.6	Maricopa	4D3	-	1,100 ±	-	20	6	0	2	3	1	2	2	2	3	1	1	In Process	None	Oil	
McFarland	4,300	1280 Total - 170 S/P 1110	3.4	McFarland Pond	5B2 4B1	150	1,500 ±	7,000 ±	30	6	1	2	2	1	1	3	2	2	1	1	None	None	Agriculture Oil	
Ridgecrest	10,325	5345	1.9	Ridgecrest	11B	115	1,200 ±	1,200 ±	19	1	8	3	3	1	2	1	2	2	1	1	None	None	Light Mfg. Navy Weapon Center	
Chafter	5,800	920	6.3	Vasco Rio Bravo	4B4 4C1	195	2,500 ±	13,500 ±	23.5	9	4	2	2	1	1	2	2	2	1	1	Complete	None	Agriculture Oil	
Taft	4,285	1260	3.4	Taft	4D2	-	2,000 ±	-	24	2 BV 8.5 SA	0	2	3	1	2	2	2	2	1	2	In Process	In Part	Oil Lt. Mfg. Agriculture	
Tehachapi	4,370	2460	1.8	Tehachapi North Tehachapi South	8D2 8D3	180	400	400	3.5	2.5	36	2	3	1	2	1	2	2	2	2	None	None	Agriculture Mining	
Vasco	8,550	1075	7.9	Vasco	4B4	155	2,100 ±	13,000 ±	32	12	3	2	2	1	1	3	2	2	1	1	None	None	Agriculture	

- (1.) Distance to Epicenter magnitude 5 or greater.
- (2.) Distance from approximate center of a community to nearest fault displacing quaternary sed. or showing movement within historical time.
- (3.) Within 5 mile Radius of approximate community center between the years 1932 to 1971.
- (4.) Soil that may experience foundation failure, mud flow or liquefaction.
- (5.) Severity Scale: 1-Low 2-Moderate 3-High.

Table 4

HISTORICALLY ACTIVE FAULTS*

Name of Fault	Location by Index Map No.	Last Known Movement	Fault Type	Evidence of Existence	Length (Miles)	Possible Magnitude
Big Pine	5E3, 5E4	1852	Normal?	Surface	50 ⁺	7.0 to 8.0
Buena Vista Hills Thrust	4D2	Creeping	Overthrust	Surface	1 3/4	-
Kern Canyon	7B, 7C, 8A, 8B	1868	Reverse & Left Strike-Slip	Surface	85 ⁺	7.0 to 8.0
Kern Front	5B4, 5C1	Creeping	Normal?	Surface	6 ⁺	-
New Hope	5B4	Creeping	Normal?	Surface	2 ⁺	-
San Andreas	1B2, 1B3, 1B4, 1C1, 2C2, 2C3, 2C4, 3D2, 3D4, 4E1, 4E2, 4E4, 5E3, 5E4, 6E3, 6E4	1857	Right Strike-Slip	Surface	600 ⁺	8.0+
White Wolf	5D4, 5E1, 6D1, 6D3, 6D4, 7C3, 7C4, 7D2	1952	Left Strike-Slip & Reverse	Surface	33 ⁺	7.5 to 8.0

*Historically active faults having one or more of the following features:

- Surface rupture -- with recorded earthquake.
- Tectonic creep--slow ground displacement usually without accompanying earthquakes.
- Seismic activity--alignment of earthquake epicenters including microearthquakes, related to a fault mapped at the surface.

Historical records of earthquakes in California begin with the year 1769.

QUATERNARY DISPLACEMENT, WITHOUT HISTORICAL RECORD**
(6 MILES OR MORE IN LENGTH)

Name of Fault	Location (Index Map No.)	Fault Type	Evidence of Existence	Length (Miles)	Possible Magnitude
Cantil Valley Fault	10C1, 10C3, 10C4, 11C2	Normal	Surface	22 ⁺	6.5
China Lake	11B	Normal	Surface	15 ⁺	6.5
Cottonwood	8E2				
Cottonwood	6D4				
Cummings Valley	7D1, 7D2, 7D2	Normal	Surface	10 ⁺	6.5
Deepwell	5B1	Normal	Surface	10 ⁺	6.5
Edison East	6C4, 7C3	Normal	Surface	8 ⁺	6.0
Edison West	6C4	Normal	Surface	6 ⁺	6.0
Elk Hills	3C4	Normal	Surface	6 ⁺	6.0
Elling Springs	1B1, 1B2	Normal?	Surface	7 ⁺	6.0
Garlock	6E3, 6E4, 7E1, 7E2, 7E3, 8D1, 8D3, 8D4, 8E2, 9C, 9D, 9D3, 10C1, 10C3, 10C4, 11C2	Left Strike-Slip	Surface	150 ⁺	8.0
Hodgeman Ranch	5A4, 5B1, 5B4	Normal	Surface	20 ⁺	6.5
Indian Wells Valley	10B	Normal	Surface	9 ⁺	6.5
Jasmin	5B1, 5B4	Normal	Surface	9 ⁺	6.5
Little Oak Canyon	7E1, 8E2	Normal	Surface	7 ⁺	6.0
Lockhart	10D, 10D1, 10D2	Normal	Surface	43 ⁺	7.5
Lockhart, South	10D1, 10D2	Normal	Surface	15 ⁺	7.0
Mt. Poso	6B3, 6C2	Normal	Surface	9 ⁺	6.5
McVan	5B1, 5B4	Normal	Surface	10 ⁺	6.5
Pinyon Hill	7E1, 7E2, 7E3	Left Strike-slip	Surface	12 ⁺	6.5
Pleito Thrust	4E1, 5D4, 5E1, 5E2, 6E1, 6E2	Overthrust	Surface	25 ⁺	7.0
Premier	5A4, 5B4, 5C1	Normal?	Surface	26 ⁺	6.6
Rodemacker	10B, 11B	Normal	Surface	15 ⁺	6.5
Ridgecrest	11B	Normal	Surface	11 ⁺	6.5
Sierra Nevada	9B, 9C, 10A, 10B	Normal	Surface	40 ⁺	8.0 ⁺
Spring	11E2	Normal	Surface	15 ⁺	6.5

**Recognized by Surface evidence such as: displaced alluvium, terraces, or other Geomorphic features: offset streams, alignment of sag ponds, fault trenches. Includes concealed fault-controlled ground water barriers or cascade in Quaternary sediments as indicated by water well data.

FAULTS DISPLACING ONLY PRE-QUATERNARY ROCKS
(6 MILES OR MORE IN LENGTH)

Name of Fault	Location (Index Map No.)	Last Known Movement	Fault Type	Evidence of Existence	Length (Miles)	Possible Magnitude
Aldo	1B1, 1B2	Cretaceous	Normal	Surface	6 ⁺	6.0
Bacon Hills	2C1, 3C2, 3C3	U. Miocene	Normal?	Surface & Subsurface	9 ⁺	6.5
Beam Flat	4D3	Miocene	Normal?	Surface	5 ⁺	6.0
Bear Mountain	7D1, 7D2	Mesozoic	Normal	Surface	10 ⁺	6.5
Blake Ranch	11E3	Mesozoic	Normal	Surface	18 ⁺	6.5 to 7.0
Breckenridge East	7B, 7C	Mesozoic	Normal	Surface	9 ⁺	6.5
Breckenridge West	7B, 7C, 7C4	Mesozoic	Normal	Surface	9 ⁺	6.5
Bull Run	7A, 7B, 8A	Mesozoic	Normal	Surface	9 ⁺	6.5
Cache Creek	8D1	Miocene	Normal	Surface	6 ⁺	6.0
Cook Peak	8A, 8B	Mesozoic	Normal	Surface	15 ⁺	6.5 to 7.0
Deep Creek	7a, 7B, 8B	Mesozoic	Normal	Surface	10 ⁺	6.5
El Paso	10C1, 10C2, 10C3, 11C2	Mesozoic	Normal	Surface	18 ⁺	6.5 to 7.0
Erskine Creek	8B	Mesozoic	Normal	Surface	7 ⁺	6.0
Goat Ranch	8B	Mesozoic	Right Strike- Slip ?	Surface	10 ⁺	6.5
Greeley-Rio Bravo	4C1, 5C2	Miocene	Normal	Subsurface	7 ⁺	6.0
Jawbone	9C1, 9C4	Mesozoic	Normal	Surface	11 ⁺	6.5
Jewett	6C1, 6C2	Miocene	Normal	Surface & Subsurface	10 ⁺	6.5
Kern Gorge	4C1, 6B3, 6B4, 6C1, 7C, 7C2	L. Miocene	Normal	Surface & Subsurface	18 ⁺	6.5 to 7.0
Louhman	11E2	Mesozoic	Normal	Surface	13 ⁺	6.5
Lone Tree	9D	Mesozoic ?	Strike-Slip	Surface	8 ⁺	6.5
Mirage Valley	10E4, 11E3	Mesozoic	Right Lateral	Surface	20 ⁺	6.5 to 7.0
Muroc	9D4, 10D, 10D3	Mesozoic	Normal	Surface	16 ⁺	6.5
Phillips Ranch	8D1, 9D	Miocene	Right Strike-Slip	Surface	10 ⁺	6.5
Pinyon Peak	8A, 9A, 9B	Mesozoic	Normal	Surface	23 ⁺	7.0
Plute	8B, 8C	Mesozoic	Normal	Surface	20 ⁺	7.0
Polonio	1B1, 1B2, 2B3	Miocene ?	Overthrust ?	Surface & Geophysical	14 ⁺	6.5
Poso Creek	6B3, 6B4, 5B4	Pliocene ?	Normal	Surface & Subsurface	10 ⁺	6.5
Ravens Pass	1B1, 1B4	Miocene	Normal	Surface	7 ⁺	6.0
Rosamond	8E1, 8E4, 9E1, 9E3, 9E4	Mesozoic	Normal	Surface	14 ⁺	6.5
Skull Creek	9D	Miocene ?	Left Strike-Slip	Surface	7 ⁺	6.0
Split Mountain	8A, 8B	Mesozoic	Normal	Surface	6 ⁺	6.0
Tejon Canyon	6D1, 7D3, 7D4	Mesozoic	Normal	Surface	7 ⁺	6.0
Trico	4A3, 4A4, 4B1	Miocene	Normal	Geophysical	10 ⁺	6.5

Table 7

GEOLOGICAL TIME SCALE AND EVENTS IN THE KERN REGION

ERA	Period	EPOCH (or "Period")	RADIOMETRIC AGE Million Years Before Present	STAGE Marine Forami- niferas	FORMATION Marine except when noted (T.)	STAGE Terrestrial Mammals	FORMATION Terrestrial except when noted (M.)	IGNEOUS & METAMORPHIC ROCKS	OROGENY
CENOZOIC	Quaternary	HOLOCENE or RECENT			Alluvium: River & Lake deposits; Untilted, (T.)		Alluvium - untilted		
		PLEISTOCENE	0.01		+++++ Alluvium, Tilted, (T.) Tulare, (T.)	Rancholabrean Irvingtonian 1.5	+++++ Alluvium - tilted McKittrick tar seeps. Ricardo- upper	Black Mt. basalt +++++	Sierra last uplift Coast Range
	Tertiary	PLIOCENE	3.	Repetian	San Joaquin Etchegoin-Jacalitos	Blancan 4.0	Kern River /	and site flows basalt flows tuffs	
		MIOCENE	9.	"Delmontian" Mohnian	Sta. Margarita	Hemphillian 10.	Chanac /	Horned Toad +++++	San Emigdio Tehachapi
			12. ?	Luisian	Monterey Temblor	Clarendonian 13.	Ricardo- lower +++++		Sierra new movts.
			14.	Relizian					
			15.3	Saucesian		Barstovian 17. Hemingfordian 21.	Upper Tropico	Bopesta Kinnick +++++	
			22.5						
		OLIGOCENE	26.	Zemorian Refugian	Wagon Wheel Tumey	Arikarean 26. Whitneyan Crellan *	Tecuya /	Saddleback basalt Ilmon / andesite	San Emigdio
		EOCENE	35.	Narizian Ulatizian Penutian	Kreyenhagen Pt. of Rocks "Tejon" Domengine Avenal	Chadronian * Duchesnian * Uintan * Bridgerian * Wasatchian *			seafloor warping
			55.						
		PALEOCENE		Bulitian Ynezian	"Meganos" Lodo +++++ "Martinez" Morano	Clarkfordian ? Tiffanian ? Torrejonian ?	+++++ Goler +++++	Witnet +++++	Garlock flt 1st movt. ?
	MESOZOIC	CRETACEOUS	65.		Panoche Gravelly Flat Franciscan			PLUTONS: Cathedral Range Huntington Lake Yosemite *	San Andreas flt. 1st movt.
			135.		" ? metamorphics			Inyo Mts. *	
			190.		*			Lee Vining *	Sierra early
	PALEOZOIC	PERMIAN	225.				+++++ Garlock (M.)		
			280.		?			Pampa schist ? Kernville ? series	Antler (ancestral Sierra)
		PENNSYLVANIAN	320.		?				
		MISSISSIPPIAN	345.		?				
		DEVONIAN	395.		*				
		SILURIAN	430.		*				
		ORDOVICIAN	500.		*				
		CAMBRIAN	570.		*		+++++		
PRE-CAMBRIAN		PROTEROZOIC	3,000.		?		Mesquite Schist ? Rand-Pelona schist	Johannesburg ? gneiss & marble. Rand schist ?	
		ARCHAIC	3,500.		?				

Notations: M : Marine sediments
T : Terrestrial, non-marine sediments
++++ : Unconformity

* : Presently unknown in Kern County
/ : Formations in unrelated stratigraphic sequence
? : Uncertain age or relation

René L. Engel
(1974)

VI

HAZARD AND RISK ANALYSIS

A. GENERAL STATEMENT

In this element, hazard is defined as an event happening unexpectedly such as an unforeseen accident or disaster due to a cause either natural or man-made. Consequently, hazard is a random event, unpredictable and only evaluated on a relative severity scale established on our present knowledge of facts pertaining to a specific hazard. Risk is defined as the value of a possible loss resulting from the effect of a certain hazard occurring at a definite location at an indefinite time. A risk is thus a quantity expressed as a monetary loss which may happen any time but varies in amount with the change of location.

This section is a review the methods of regional seismic hazard analysis leading to corresponding risk evaluation. Discussions of potential hazards are presented in Chapters III and IV and their areal distribution is shown on the quadrangles of the Seismic Hazard Atlas. On the basis of those data the following principles may be formulated:

1. The relative severity of a definite hazard in a given area may be expressed by a scale: Low - 1; Moderate - 2; High - 3. These factors are used on Table 4 of Combined Hazards Evaluation and Tables 10-13 in the Planning Guide to the SSE for Kern County.
2. Convergence of superposition of several hazards in one area tend to increase the severity factor.
3. Increased distance from faults or epicenters tend to decrease the severity factor; the converse is also true. For instance in the tables mentioned above the shaking severity factor expresses the result of the composite analysis of seismicity represented by the number of epicenters within a five mile radius, the distance to the nearest "young" fault and the probable shaking by a past earthquake of magnitude equal or greater than 5 when damage begins. Similarly, other severity factors are estimated by analyzing all available data for each problem. For example, the failure of foundations is related to clay soils and subsidence. Extensive damage to communities and highways even near moderate slopes are caused by landslides and mud-flows. Building resistance to seismic stresses generally decreases with age increase, etc.

B. CONVERSION OF HAZARDS INTO RISKS

The earliest method used is based on the attempt to relate specific losses to the earthquake intensity (Mercali scale, Table 2) in the area of greatest damage and intensity (meizoseimal sone). Variability of earthquake characteristics, environment, as well as uncertainty inherent to the intensity scale and poor records, prevented that method from giving reliable data generally applicable to risk evaluation. Only in the cases of thoroughly investigated earthquakes with their respective estimated losses should there be enough actuarial data

to establish some regional risk values for different types of damage and hazards. However, that material is apparently lacking even in the most recent publications on earthquake damages.

In older publications such as that on the Earthquakes in Kern County during 1952 (Ref #5) although very detailed in many respects, the separate damage costs to buildings in Arvin and in Tehachapi are not given. For Bakersfield, the combined damages caused by the main shock of July 21 and the aftershock of August 22 are estimated at \$23 millions. Assuming that this total loss is amortized by taxation by the population of the incorporated city in one hundred years, the annual tax burden would progressively decline with increase population from about \$5. to \$1.70 per person (one hundred years is the estimated recurrence interval between destructive earthquakes in Kern County - see Page IV-19 of the Geology and Earthquake Hazards, Planning Guide to the SSe for Kern County.") Another approach to the evaluation of risks to buildings is to calculate the probability of collapse of a structure for the maximum ground wave velocity during an earthquake at a given location. (Ref. #22) That method assumes a complete destruction of a structure and seems to be unadapted to cases where salvage and repairs are considered.

C. ACCEPTABLE RISK

The acceptable risk is the dollar amount society is willing to pay for the prevention and partial compensation for the losses caused by a disaster or several hazards. That acceptability depends upon the value of the savings or benefit (B) realized by decreasing the amount of probable loss the expenditure of the acceptable risk or cost (C). The estimated values of cost ratio (Benefit-Cost) for the following hazards, are:

Expansive soils	20:1	Fault displacement	1.7:1
Landslides	9:1	Subsidence	1.5:1
Earthquake shaking	5:1	Floods	1.3:1

The order of potential risks listed above reflects the relative efficiency of loss-reduction methods when applied to these problems. (Ref #21, p.84)

D. BALANCED RISK.

This concept of acceptable risk to a community is based on the design of earthquake resisting structures, which having a safety probability against death, equal to the risk of getting killed in an automobile accident (about one person in one million per year). Earthquake lateral forces are pre-determined by that risk and increase with the life on the building. The average number of persons exposed daily and the type of occupancy in the building also enter into the design as importance factors in determining the balanced risk.

The balanced risk concept was developed by John H. Wiggins, Jr. for the new building inspection code accepted by the City Council of Long Beach in 1971. It serves as a basis for the evaluation of earthquake hazards of existing structures and for reducing this hazard. Buildings are rated on a priority basis for inspection which mainly depends upon the type of construction, physical state, degree of occupancy, nature of soil and foundation. When a building gets a high

priority rating, a serious hazard to life exists and it calls either for demolition or major strengthening. (Ref. #23)

E. ANTICIPATED RISK

The Anticipated Risk approach to risk analysis is presented in Urban Geology-Master Plan for California (Ref. #21) and has for its major objective the reduction of losses caused by geological hazards in California. In order to provide a common basis for comparative evaluation of hazards, a hypothetical "Urban Unit: having a population of 3,000 and a total value of \$90 million is used to measure the simulated impact of each of three severity levels or zones for every hazards. By 1.) moving the "Urban Unit: in each severity zone and hazards, 2.) calculating the costs of anticipated damage and considering the loss per event, 3.) estimating the average recurrence period between events and 4.) evaluating the life loss potential at \$360,000 per life lost; the anticipated average annual loss per capita can be obtained for each security level and hazards.

The revised values of these annual losses, called geological points (GP), obtained by applying the disaster factors listed on page 80 of reference 21, are as follows:

<u>Hazard</u>	<u>LOW</u>	<u>MEDIUM</u>	<u>HIGH</u>
Earthquake shaking	\$21.0	\$54.0	\$93.0
Fault Displacement	0.06	0.5	5.5
Landsliding	1.0	35.0	58.3
Flooding	0	96.0	290.0
Erosion activity	1.0	2.0	3.0
Expansive soils	0	2.0	3.0
Subsidence	0	0.02	0.34

The anticipated losses caused by the occurrence of several hazards in a definite predefined area, such as a 7½ minute quadrangle, is equal to the sum of geologic points of all individual losses for each hazard affecting that area at a certain severity level.

The priority assigned a given locality scheduled to receive geologic loss-reduction work or financial assistance from the state could be expressed by the formula: $PP = (GP) \times PY \times IF$

When:

PP= Priority Points factor

S(GP)= Summation of geological points of all individual losses for each hazard and severity level

PY= Person - Year Exposure expresses the average number of residents in the given area until the year 2000

IF Immediacy Factor expresses the rate of projected growth until the year 2000

Application of this method of determining a priority factor to Kern County areas around cities and regions of high development potential may have a distinct usefulness in orienting future loss-reduction policies.

It is worth noting that in 1952 the annual loss per capita for structural damage in Bakersfield is estimated above at \$5.00 (see p. V-4). The figure does not include the value of lives lost, but in this instance inclusion of the dollar valuation that would be ascribed to the two fatalities is small relative to the total dollar loss and would not change the figures above.

By contrast, the last computation method for earthquake shaking of medium severity which applies to Bakersfield, gives an annual loss per capita figure about ten times that of 1952. It may indicate that additional scrutiny of methods used to establish anticipated risk and priority factors is in order.

F. EXPECTABLE EARTHQUAKES

The geologic and historic record clearly indicate that earthquakes are certain to happen in California. This is bolstered by evidence from geodesy on the rate at which strain is accumulating in the rock. The pattern of earthquake occurrence in California is of help to us in estimating seismic risk.

In Southern California, at least, large earthquakes do not as a rule have identifiable foreshock sequences. Most come without any noticeable preamble. They are followed by aftershocks that gradually spread out from the area in which the main shock took place. Elsewhere, foreshocks may signal a coming event by occurring for a week or more beforehand. It is uncommon for small earthquakes to take place on or along large faults in our area. Many of the small shocks are part of an aftershock series and most of them occur in the regions between major faults systems.

A lack of seismic activity in an area may not mean that the area is safe. Perhaps the largest earthquake in the United States in historic time took place in the Mississippi Valley in 1812. There has been almost no activity in the area since. The southern part of the region affected by the Chilean earthquake of 1960 had felt no important earthquakes since 1935 and many of the older residents could not remember having felt an earthquake in their lifetimes. Of the recent earthquakes that befell California, the faults involved were not thought to have been active or not regarded as likely to produce important earthquakes. This may of course be due to a lack of appreciation of the criteria for fault activity, but it serves to point up the problem.

The largest expectable earthquake anywhere, based on the Richter Scale is about magnitude 8.6. The reason for this is that the scale is so compressed at the upper end that no matter how much larger an earthquake may be, it is not likely to be interpreted as being much larger. In California, we experienced earthquakes approaching this size. The Owen's Valley earthquake, the San Francisco earthquakes and the Ft. Tejon earthquake were all in excess of magnitude 8. Even large as these were, there exists no basis for believing that Los Angeles will fall into the sea or for predicting catastrophes of the sort that one hears about on the television and in the popular press.

On the basis of recurrence rates of smaller earthquakes, on the basis of geodetic measurements of strain accumulation and the amount of strain released by earthquakes; various estimates have been made for the recurrence rates of large earthquakes. It is generally thought that the San Andreas fault will yield an earthquake approaching or exceeding magnitude 8, somewhere along its length at least once or perhaps twice a century.

It is not important to know the exact recurrence interval. If it were only of concern that property might be damaged, it would be more economical and even practical to ignore the earthquake situation. However, a number of economic interests such as public safety and the preservation of life are involved.

A large earthquake taking place now in California would be capable of causing an economic disaster of such proportions that it would bankrupt the state and have a severe effect on the whole of the United States. It is therefore imperative that, even with the low recurrence interval, that construction be built to withstand earthquakes of at least magnitude 8.5.

The area affected by a large earthquake is so great that destructive effects would be felt in Kern County from one taking place say in the Imperial Valley, or near San Francisco. The long period waves from the larger earthquakes are capable of doing damage to flexible structures at a great distance. We must therefore consider the possibility of an earthquake in a neighboring county severity affecting Kern County.

There is little reason to feel that any part of the county is expecially favored in being free of the effects of earthquakes. It is true that some parts are more certain to be severely shaken than others. Thus the immediate area along the San Andreas and Garlock Faults might require more attention to earthquake codes, or more rigorous coes, than the rest of the county.

The design earthquake for Kern County should be thought of as perhaps two design earthquakes. Magnitude 8.5 as the upper limit, with consideration for the effects of long duration of shaking and the effects of long period waves. Magnitude 6 as a lower limit, with consideration for the effects of high frequency shaking of short duration.

GEOLOGIC HAZARDS IN CALIFORNIA

TO THE YEAR 2000:

A \$55 BILLION PROBLEM

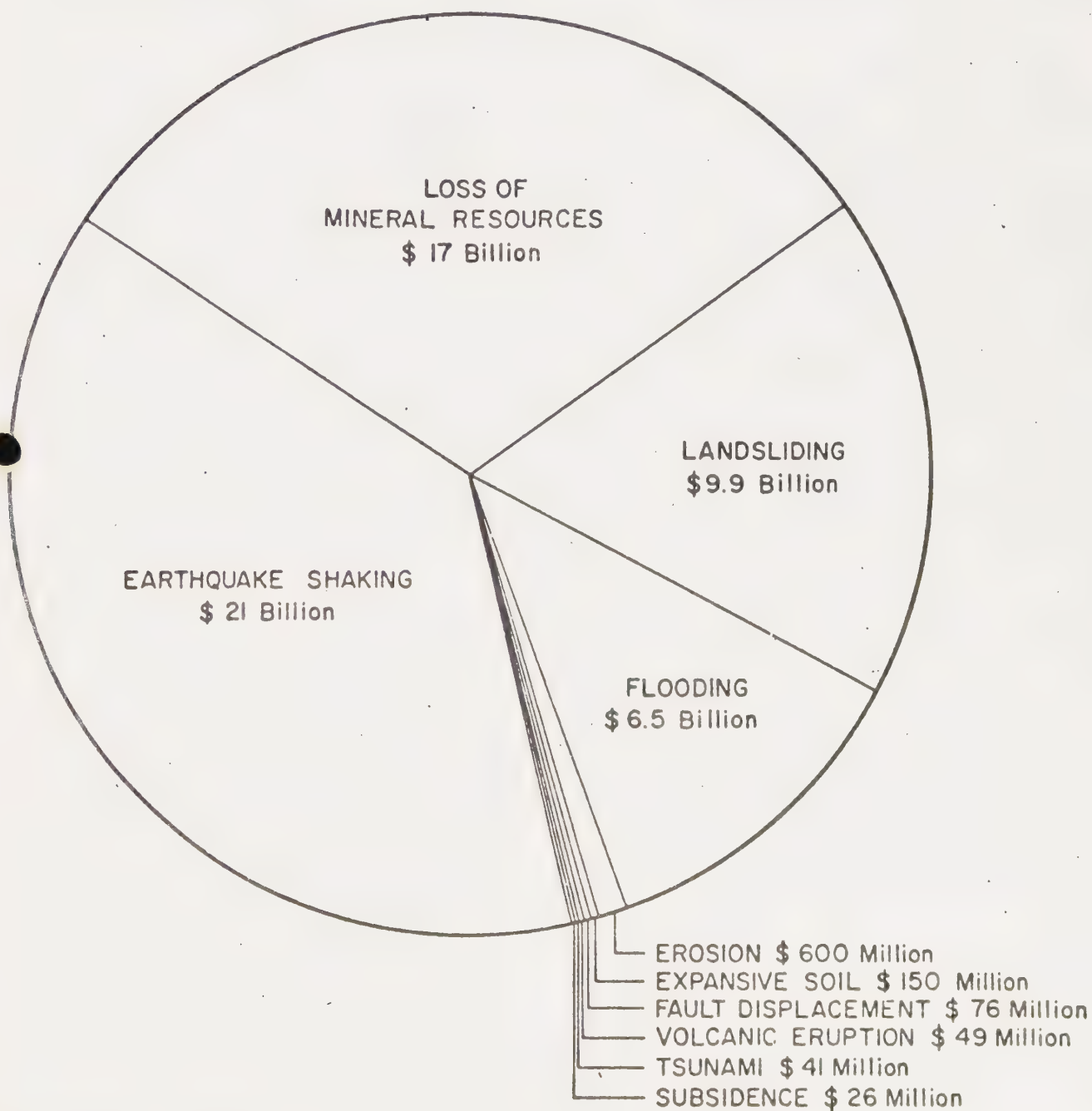


Figure I

Geologic hazards in California to the year 2000: a \$55 billion problem. Estimated magnitude of losses due to ten geologic problems in California projected from 1970 to the year 2000, if current loss-reduction practices continue unchanged.

VII LAND USE PLANNING

A. GENERAL STATEMENT

In attempting to decide the best approach to minimize potential earthquake damage at a specific site, it is essential to distinguish between problems that can be compensated for in design, those that cannot, and those economically unfeasible. Seismic problems that cannot be compensated for or which result in prohibitive expense for most uses are: (1) ground rupture or vertical and horizontal offset along a fracture, (2) soil liquefaction at substantial depths, and (3) landslides of regional extent.

Basically, there are two ways to respond to any problem: either remove the cause of the problem or accommodate to the problem situation. Generally speaking, it is impossible to remove the cause of the earthquake. It is technically possible under some circumstances to accommodate to the problem situation. However, in this category it is rarely economically feasible to design structures against ground ruptures which produce significant vertical or horizontal offset along a fault. The area of the rupture is relatively small, so the total extent of damage due to this feature is somewhat less than that caused by ground motion, either acting directly on the building or indirectly by triggering the mechanism that produces mechanical failure of the ground structure, such as soil liquefaction and landslides. Construction in any area affected by fractures, liquefaction and landslides should be avoided. However, if construction is proposed it should be preceded by a thorough engineering study to delineate the dangers and to identify corrective measures.

The consequence of strong shaking are of greater significance over a far wider area than are those of local ground rupture due to fault movement. However, the seismic shaking and most of the indirect effects can usually be compensated for by adequate design.

The previous sections have described the earthquake problem and have geologic information that can provide valuable data regarding the possibility of ground rupture, landslides and earthquakes shaking. However, this information is of no great value if steps are not taken to utilize it and alleviate the consequences of earthquakes and related seismic events. An inventory of existing physical hazards is essential and has been compiled graphically on maps of the community. Implementation of a plan within the hazardous zone is accomplished by the application of zone classifications and building codes.

*
The outline in Appendix H can be used as a guide in the preparation of engineering geology reports when it is determined by the Public Works Department that such a report is necessary.

* "Geology and Earthquake Hazards", planners guide to the Seismic Safety Element Kern County, California.

1. UTILITIES HIGHWAYS AND DAMS

The data available to use concerning the various utilities, including water, power, gas, telephone, fuel lines, and the highways are generally shown on the Quadrangle Maps included with this report. Not shown thereon are the many feeder lines and minor distribution systems which naturally must be located wherever service is needed. Many of these services are underground, and are highly susceptible to either subsidence or liquefaction. Aside from damage related to ground shaking which may be prevalent over the entire area, it is obvious in comparing the physical layout of the services with data presented on the geological sheets, that there are major problem areas where the services cross active faults.

2. FREEWAYS

North-south highways include Interstate 5, State Route 99, and 14-395. The main east-west highways that traverse the county are Highways 58 and 178. There are many overpasses and freeway structures in the study area. Considering ground shaking alone, the San Fernando 1971 Earthquake has indicated that these structures as built in California will be subject to damage. Because of the type of seated connections at the abutments, it must be expected that many of these structures will fail. Even without that hazard, the highway in the Grape-Vine area will be subject to the effects of landslide. These highways also traverse zones of liquefaction as well as crossing the Garlock and Whitewolf faults. It must be expected that not only the overpass structures, but the highways between these structures are vulnerable to damage. Highway approach fills - especially at low elevations - are subject to damage. In disaster planning for any major earthquake, it must be expected that the freeways will be closed for an appreciable period of time and that alternate routes will be necessary.

3. SEWERS

The main lines, connecting developed areas with the treatment plants, are underground. The major danger to these lines is from shaking while in some areas they may be sheared by fault movement. It must be expected that these will all be damaged severely. This loss of sewer capability is always a serious problem.

4. FUEL LINES

The petroleum tank farms, in some producing areas, are connected by fuel lines to the refinery and/or other portions of the county, by lines which cross the fault. It is probable that ground displacement and shaking in an earthquake will cause these lines to rupture, even if the lines are well designed to resist ground motion. We understand that these lines are valved to limit damage in the event of breakage, but it must be expected that there will be loss of service. Since the liquefaction potential has only rather recently been recognized by many engineers, it is suggested that the valve locations and operations be reviewed. Steps should be taken to reduce the fire hazard and contamination from oil spills.

5. WATER

Water for the study area is supplied by several Municipal Water Companies from underground sources. It must be expected that major conduits will be damaged and out of service following a major earthquake.

It is our understanding that all water pipelines of welded steel construction are the best and most ductile form of construction when unknown earthquake deformations must be accommodated. If ground deformation is nominal, it is most probable that few if any ruptures will occur. However, it is inevitable that with large motions some breakage will occur. If this occurs to the lines leading from the storage tanks, it is probable that the contents may not be available for use in some of the project area. The main water lines in some cases go roughly parallel to some of the main sewer supply lines. When breaks occur on both systems there is a major possibility of contamination of the water supply as happened in Anchorage in 1964.

Because of this probability, emergency plans should be developed to determine the potability of the water supply immediately after earthquakes of significant intensity and to proceed with the repair.

6. DAMS

There is only one major dam that affects the study area, the Lake Isabella Reservoir. The dam that creates this reservoir was built to the best standards of its day, and its subsequent operation has been supervised closely. Until the 1971 San Fernando Earthquake, there was no question as to its safety in even major earthquakes. However, because of the near failure of the old hydraulic filled lower San Fernando Dam, the State Division of Safety of Dams has required that all hydraulic fill dams in the state be re-examined as to their safety. The Lake Isabella Dam is a rolled earth-fill dam. However, the Kern Canyon Fault passes along the west abutment of the auxiliary dam and is a major seismic hazard for the Hot Springs Valley communities.

In the last legislature, a requirement was initiated as a precautionary measure, that the State Department of Emergency Services map the downstream areas of all dams that might be inundated in case of dam failure. Such a map is in the process of being prepared at this time and should be available this fall. It will probably show that some of the San Joaquin Valley area will be included, although the actual area is indeterminate at this time.

7. TELEPHONE

Many of the telephone conduit lines connecting with areas outside the study area can be expected to be damaged. However, the telephone system uses various routes and types of transmissions, and it can be expected that alternate routes, microwave pathways, etc., will be available. Past earthquakes have indicated two greater hazards - overloading of lines due to too much use and equipment or power failure.

We understand that methods are being investigated to attempt to limit user loads on the system so that critical or emergency calls can go through. We do not know the status of such investigations, nor their probabilities of success. Regarding equipment, the Pacific Telephone and Telegraph Company, the utility serving the project area, has had extensive successful experience in the Kern County and Eureka Earthquakes and a forerunner of the company served San Francisco in the 1906 earthquake. Their equipment bracing practices are quite different and more substantial than in other areas of the country or in other systems. However, the newer equipment is much more complex and sophisticated and with complexity there are greater opportunities to overlook critical details, so any reliance on telephones in the first few hours after an earthquake must be minimal. The record of the various telephone companies in assembling emergency equipment and providing communication has been excellent in even the worst disasters.

8. GAS

Gas lines cross some of the faults and some areas subject to liquefaction and/or landslide. Service can be expected to be disrupted and valves will need to be closed or will automatically close in order to isolate damaged lines.

9. POWER

The main power supply lines serving the area cross some of the faults and unstable ground. Overhead structures will be less damaged than underground installations. However, there will be damage to substations, etc., as well as to certain overhead lines. The distribution systems with their transformers will be substantially damaged and could cause fires.

B. POLICIES

The following policies are suggested to assist the decision-maker in evaluating proposed projects in hazardous seismic zones.

- Obtain adequate data so hazardous areas can be identified.
- Plan appropriately in high risk areas - those with possibility of ground rupture or offset, shaking, landslides, and liquefaction - under strict design requirements and for low density use.
- Adequate grading and building code restrictions shall be applied in the design and construction so that damage is minimized.
- Enforcement of building codes is essential. Most failures of structures in earthquakes are related to a lack of inspection during the construction phase, to unauthorized changes following construction or to a failure to follow existing codes. This phase of the work requires less study than does the identification of hazards, the planning, design and the construction. Neglect of this phase can easily cancel all the good effects of the other work.

The benefits derived from the policies stated above do not just happen. They are the result of action authorized or required by legislation at the federal, state, and local level. A comprehensive zoning ordinance is essential in order to implement these policies; however, the building codes are the primary tools government possesses to reduce seismic risk in structures.

C. STANDARDS FOR DIFFERENT LAND USES AND ZONES

Differing degrees of acceptable risks should be assigned to various types of structures.

1. Emergency Operation Centers and Other Essential Facilities

Critical. Public facility uses, such as hospitals, fire stations, police stations, emergency operation and communication centers, and major power complexes are essential to post-earthquake disaster operations. These vital facilities must be designed and constructed to remain functional after a severe earthquake. Therefore, the level of earthquake risk for these important facilities must be low. Through adequate earthquake-resistant designs based upon a detailed geologic-seismologic investigation for each site, provisions can be established for obtaining this basic requirement of highest level of protection.

Local government will formulate, and the public works department implement, special seismic design and site location criteria to be integrated with the following classifications of critical-use buildings and structures:

- a. Critical Occupancies - Complexes that are essential to disaster operations during and after an earthquake.
- b. High Cost Facilities - Construction of certain public facilities involving expenditures of large sums of money (total building expenditures of \$500,000 or more require detailed investigations, regardless of location).

- c. High Occupancy Facilities - Occupancy levels that are considered critical from the standpoint of seismic safety are structures that have a tentatively established occupancy level in excess of 100 person.

Comprehensive geologic-seismologic-foundation engineering investigations should be obtained for all vital public facilities. Minimum requirements for those coordinated and detailed investigations should include consideration of items D-1 through 5, page VI-7 no construction without detailed evaluation by public works of these facilities should be permitted within the zone of fracture shown as a shaded area on the quadrangle maps.

2. Community Facilities

A lower level of protection than that of Emergency Operation Center can, in general, be tolerated for community facilities. Such buildings may be asked to accommodate earthquake victims from outside the immediate area. The extent of this possibility should be determined on an areawide basis by the local jurisdiction.

Because of the relative high level of occupancy at community centers they should have a higher level of protection than other community facilities. Some structural damage can be tolerated, but the facility must be designed and constructed to remain intact and not endanger the lives of its occupants.

Minimum requirements for coordinated and detailed investigation should include consideration of items 1 through 5, Page VI-7.

3. Open Space Uses

This classification includes agricultural, recreational, and conservational uses. Unless a high occupancy or a large structure is involved, a low level of protection is acceptable. Items 1 and 3, page VI-7 should be considered prior to approving construction.

4. Industrial Uses

Moderately heavy to light occupancy is usual for industrial uses. Because of the wide latitude in the weight and size of equipment, it is impossible to state the degree of risk that is involved. The Public Works Department must use their own knowledge, based on experience, in determining the extent of site evaluation acceptable. Items 1 through 5, page VI-7 should be required as necessary.

5. Commercial Uses

The acceptable level of risk must be low for most commercial uses, because of the unrestricted access to the public and the high occupancy factor. In general, the Public Works Department, through experience, is familiar with the general geological conditions in most commercial areas. However, for large structures or areas where the geological characteristics are in question, items 1 through 5, page VI-7 should be evaluated.

6. Housing Uses

This use traditionally has a low degree of risk because most dwellings are

relatively small, one or two stories in height, and have a minimal occupancy factor. Items 2 and 3, page VI-6 should be evaluated.

Where the occupancy factor is high, such as in multiple wall apartment buildings, motels and hotels, a lower risk should prevail and items 1 through 5, page VI-7 should be considered.

D. SITE EVALUATION FACTORS

The following factors apply to site evaluation. Different land uses accommodate varying degrees of acceptable risk, so factors in this list are applied in accordance with standards for land uses 1 through 6 above.

1. Fault Proximity - Defined as an evaluation of all the active and potentially active faults which have the capability of generating a moderate or greater (magnitude - 5) earthquake during the lifetime of the proposed structures. Additional data needed are distance to active faults, seismic history of the area, and potential for surface ground rupture due to faulting.
2. Characteristics of the Foundation Materials - Defined as an evaluation of the foundation materials on the basis of detailed subsurface exploration, laboratory testing, and geophysical studies. A determination of the static and dynamic physical properties of these underlying materials, their extent, depth to groundwater, and depth to crystalline basement are parameters needed to assess the site's seismicity. All other things being equal, these local characteristics will greatly modify the effects of earthquakes on structures.
3. Ground Failure Potential - Defined as an evaluation of the site's susceptibility to failure of the ground surface due to landsliding, liquefaction, differential dynamic settlement, and ground lurching.
4. Estimated Earthquake Parameters of Basement Motion - Basement motion parameters for the site can be estimated from empirical methods. Some important earthquake parameters are:
 - a. Maximum probable earthquake or design earthquake (Richter magnitude).
 - b. Average maximum basement acceleration (g).
 - c. Duration of shaking.
 - d. Predominant period of basement motion.
5. Ground Motion Spectrum - The influence of ground shaking on engineering structures is customarily portrayed by means of response spectrum curve. Response spectra curves are derived by a seismologist utilizing geodynamic earthquake parameters characteristic of the basement underlying the site. Basement seismic characteristics are determined by a geologist. The response spectra are then computed over a range of periods, and for a number of different values of structural damping. A quantified description of the vibratory effect of the ground acceleration on buildings is obtained by such response spectra curves.

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APPENDIX A

SEISMIC SAFETY ELEMENT

AUTHORITY

Section 65302 (f) of the Government Code of the State of California requires a seismic safety element of all city and county general plans, as follows:

A seismic safety element consisting of an identification and appraisal of seismic hazards such as susceptibility to surface ruptures from faulting to ground shaking, to ground failures, or to the effects of seismically induced waves such as tsunamis and seiches.

The seismic safety element shall also include an appraisal of mudslides, landslides; and slope stability as necessary geologic hazards that must be considered simultaneously with other hazards such as possible surface ruptures from faulting, ground shaking, ground failure and seismically induced waves.

Section 65700 of the Government Code, effective March 5, 1972 extends the law to include charter cities.

The effect of this section is to require cities and counties to take seismic hazards into account in their planning programs. The intent is that all seismic hazards are to be considered, even though only ground and water effects are given as specific examples. The basic objective is to reduce loss of life, injuries, damage to property, and economic and social dislocations resulting from future earthquakes.

APPENDIX B

REVISION OF THE SEISMIC SAFETY ELEMENT

PERIODIC UPDATING OF COMPONENTS OF THE SEISMIC SAFETY ELEMENT

A. GENERAL PLAN AMENDMENT

Although the general plan, composed of various elements, is a long-range, comprehensive policy document, it must be periodically updated to meet new conditions and from time to time revised or amplified to respond to unforeseen changes or needs. The plan is, therefore, subject to amendment or reflect changes in goals, policies and physical, social or economic conditions. Some changes may be minor and not require changes in other parts of the plan. All proposed changes, however, should be evaluated in regard to environmental impact and consistency with the balance of the document.

The procedure for amending the general plan is the same followed in the adoption of the plan. Notice of public hearing before the Planning Commission and the legislative body must be given at least 19 days prior to the hearing. Approval of the plan by both the planning agency and the legislative body must be by resolution and must be endorsed by each.

Section 65361 * restricts the number of times per year that the mandatory elements of the general plan can be amended. "No mandatory element of a general plan shall be amended more frequently than three times during any calendar year..." This provision does not apply to adding new elements to the general plan. Local agencies can amend the general plan by adding new plan elements as often as desired. For example, noise, seismic safety and other safety elements may be adopted during the calendar year and this will not constitute an action under Section 65361.* Plan elements which are not required in the planning law (e.g., urban design, specific area plans, public buildings, etc.) but may be of community interest can be amended to the general plan as often as desired. This procedure only affects proposals to change existing mandatory general plan elements. This requirement becomes effective on January 1, 1974.

Section 65862* requires that a two-week period of time be provided between the adoption or amendment of the general plan or element thereof and proposal for a rezoning for the purpose of bringing zoning into consistency with the general plan. This prohibits concurrent action to amend the general plan and the zoning ordinance at the same meeting. The two processes have been separated in order to strengthen the general plan as a policy document and the zoning ordinance as an implementing device. This requirement became effective on January 1, 1973.

B. ZONING ORDINANCES

Zoning ordinances are adopted and amended by a procedure somewhat similar to that described for adoption of the general plan (Section 65850*)

Chapter 4 of the planning act enables cities and counties to regulate the use of land in order to protect the public health, safety and general welfare. Recent amendments to the zoning law require a closer relationship between the objectives, policies, and land uses of the general plan and regulatory devices provided for in the zoning ordinance.

Section 65860 of the Government Code requires a consistency of zoning with the general plan. Updating of the ordinance is a continuing process because there must be consistency between the zoning ordinance and the general plan. This emphasizes the importance of clearly defining the purpose and nature of the zoning ordinance as a short range implementing device and the general plan as a body of long range public policy. Although many general plans are becoming more comprehensive and at the same time more detailed, the plan is intended to provide a broad base of policy for guiding decisions. On the other hand, the zoning ordinance is a set of specific legal regulations which prescribe the various uses allowed within the jurisdiction. The range of uses allowed and the standards related to each use are applied with the short range expectation that the land will be used for a particular purpose.

For this reason there will be differences of specificity between the zoning map and the general plan diagram. In addition, there will very likely be land use differences between the two in cases where the general plan includes only a single diagram indicating the intended land use pattern some years in the future. Determination of consistency, thus, is not a simple matter. It requires more than superficial comparison of the zoning map and the general plan diagram. In addition to a review of the map and diagram, it is necessary to review the text of the general plan to determine if the land uses authorized by the zoning ordinance are compatible with the objectives, policies, general land uses and programs specified in the general plan. Compatibility of the policies in the general plan and the text of the zoning ordinance should be clearly described.

Questions of type of use, intensity of use, characteristics of uses in relation to environmental values expressed in the plan should also be evaluated. Also requiring evaluation is the timing and sequence of change in use, particularly where the change is from a lower intensity to a higher intensity use. The sequence of change is particularly important and may be either covered in specific terms in the general plan or inferred.

The zoning ordinances, being current and precise, reflect the existing phase of land development, but should gradually follow the general plan into the future as appropriate in relation to timing and sequence of uses. Thus it may be inconsistent with the plan to rezone a large, low intensity use area to a more intensive use as shown in the general plan, when the transition to the more intensive use will occur so gradually that scattered use will result and contravene a general plan policy calling for compact urban development. Even though the zoning ordinance may indicate uses different from those shown in the general plan, the zoning in this case will carry out general plan policies as to orderly development, and thus is consistent with the general plan.

The zoning ordinance should be considered consistent with the general plan when the allowable uses and standards contained in the text of the zoning ordinance tend to further the policies and designated uses in the general plan and do not inhibit or obstruct the attainment of those articulated policies.

UTILIZATION OF REVIEW PROCEDURES TO ASSURE CONFORMANCE TO SEISMIC SAFETY ELEMENT

The local jurisdiction should adopt an ordinance providing for establishment of a Seismic Safety Commission which would initially be mainly advisory. This commission would not be required if the city had taken action to transfer its building inspection function to the county. The commission would be responsible for the implementation of this plan by divising local earthquake and geological hazard safety standards, encourage research, provide technical assistance and oversee other recommendations in this report.

As advisory to the local planning commission the Seismic Safety Commission should include in their recommendations to the planning and building inspection departments, ground stability tests, recording seismic hazards on subdivision maps, and making geological "blighting conditions" in terms of possible redevelopment projects. In addition they should insure that new information related to the Seismic Hazard Element be added to the plan (text and maps).

This committee should make recommendations to the state and local legislators regarding revision to the building code, destruction of older hazardous buildings, removal of hazardous parapets and similar features from buildings, more stringent standards for emergency service centers, a review of construction standards for dams and implementation of the "Safety Element," an additional state mandated element to the general plan.

Locations for construction of emergency service buildings include fire stations, government buildings which house principal emergency operating centers or base radio stations, police stations, jails and other structures which house persons physically restrained, must receive review by this commission.

Local jurisdictions must adopt minimum earthquake design requirements no less stringent than those prepared and adopted by the state. The committee should make an annual review of the Seismic Safety Plan, the zoning ordinance and the subdivision ordinance in order to insure the conformity of the plan with state law and the communities' needs.

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